

# PATENT SPECIFICATION

DRAWINGS ATTACHED

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## COMPLETE SPECIFICATION

### Curtain Coating Apparatus

10 We, CONTINENTAL OIL COMPANY, of Ponca City, Oklahoma, United States of America, a corporation organised under the laws of the State of Delaware, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

15 This invention relates to improvements in apparatus for providing a descending curtain of a liquid coating material for deposition on a substrate moved through the curtain. More particularly, the present invention relates to curtain coating apparatus which includes structure facilitating the positioning of a thinner film of coating material upon a substrate than has been possible using curtain coating apparatus of the type heretofore available.

20 In conventional curtain coating machines now in use, such as the Steinemann curtain coater, the basic elements of the machine generally comprise a coating head from which emanates a thin gravitating film of a liquid coating composition, a receptacle or container of some type disposed below the coating head for receiving the coating composition as it gravitates from a coating head, and apparatus for moving a substrate material to be coated through the film or curtain of coating composition emanating from the coating head. In the usual operation of such curtain coating machines, the coating composition is allowed to gravitate from the coating head, or is ejected therefrom under a pressure slightly exceeding atmospheric pressure, and moves through the air as a thin film or curtain extending vertically between the receiving receptacle or trough and the coating head. The liquid coating composition is recirculated from the receiving trough to the head after

being passed through suitable heating and degassing equipment.

The apparatus which is employed in conjunction with the coating head and receiving trough for completing the coating operation includes some suitable type of conveyor mechanism for moving a substrate to be coated through the gravitating film or curtain. In some instances, as, for example, where it is desired to move a flat, substantially monoplanar discontinuous substrate through the curtain, a pair of endless conveyor belts may be disposed on opposite sides of the curtain and the belts moved in the same direction so that a substrate, such as milk carton stock or the like, can be passed through the curtain by movement across the gap or open space existing between the two conveyors. In other applications of the curtain coating machinery, an elongated continuous web is to be coated. In this instance, suitable feed and take-up rolls are provided on opposite sides of the vertical plane of the gravitating curtain, and the web is transferred between the feed and take-up rolls so that its span between the rolls passes through the gravitating curtain.

Whether the curtain coating device is to be employed for coating a discontinuous, relatively short substrate, such as milk carton stock and the like, or is to be used for coating continuous webs, the thickness of the deposited layer or coating is frequently critical and always a major concern. The thickness of the coating laid down on the substrate will generally be dependent upon the speed at which the substrate is moved through the gravitating curtain and the rate at which the coating composition is being released from the coating head. In general, the first evidence which is observed that the limit of thinness of the applied coating has been

reached is the appearance of discontinuities, breaks and fractures in the applied coating. Once the coating fails to completely cover the substrate and bare spots or breaks appear in the coating, any further attempt to reduce the thickness of the coating by control of the flow of coating composition, or increasing the speed of the substrate through the curtain, will only result in aggravation of the coating discontinuity and the increasing frequency of breaks and imperfections in the coating.

The present invention comprises an improvement in curtain coating apparatus which permits the minimum thickness of coatings which are applied to substrates moved through the gravitating curtain to be further reduced, and yet thinner coatings to be applied. According to the invention there is provided a curtain coating apparatus, comprising a slotted coating head arranged to provide, when in use, a gravitating curtain of a liquid coating composition emanating from the slot in the coating head, means for conveying a substrate through the curtain and below the coating head in a direction extending substantially normal to said gravitating curtain, and a horizontally extending knife edge extending generally parallel to a vertical plane containing the slot in said coating head and horizontally spaced from said plane, said knife edge being positioned at a vertical level such that it is able to contact the upper surface of said substrate just before the substrate is moved through said gravitating curtain by said conveying means.

The thin rigid edge or knife blade is desirably spaced from the gravitating curtain by a distance of from about 1 to about 5 inches. Preferably, the knife blade is spaced from the gravitating curtain by about 1-1/2 inches, or as close to the gravitating curtain as possible, and is adjusted to bear lightly against the surface of the substrate which is to be coated. The advantageous effect of employing the described structure which constitutes the present invention is to permit relatively thin coatings to be applied to the substrate with a consequent saving in the cost of coating material, and an improvement in the functional capabilities of coated substrates for some uses which require a very thin film of the coating material on the substrate.

In a preferred embodiment of the invention, a rigid member carrying a knife edge which is placed in contact with the substrate to be coated is used conjunctively with a shield which is brought into contact, and operates, with the knife edge bearing member to form a continuous shield or obstruction extending vertically and parallel to the gravitating curtain so as to block the movement of air currents toward the curtain.

In yet another embodiment of the invention, the member which carries the knife blade or elongated edge of reduced thickness

is hollow, with the hollow interior thereof opening at the knife edge so that a vacuum may be drawn through the member, or air or other suitable gas under pressure may be forced through the member and out through the opening adjacent the knife edge. In this embodiment of the invention, a force developed by reduction or increase in pressure can be brought to bear on the substrate to be coated along the line thereof which is contacted by the knife edge.

From the foregoing description of the invention, it will be perceived that a major object of the invention is to provide an improved curtain coating device which can be effectively employed for depositing relatively thin coatings of a molten coating composition on a substrate material.

An additional object of the present invention is to provide a device for reducing the thickness of uniform continuous coatings which are applied to substrate materials by a curtain coating procedure.

Another object of the present invention is to provide an improved curtain coating device which is mechanically strong, relatively easily utilized and characterized by a long and trouble-free operating life.

In addition to the foregoing objects and advantages, additional objects and advantages will become apparent as the following detailed description is read in conjunction with the accompanying drawings which illustrate the invention.

In the drawings:

Figure 1 is a schematic illustration of the manner in which the apparatus constituting the improvement of the present invention is utilized in conjunction with the basic elements of a curtain coating apparatus.

Figure 2 is a perspective view of an improved curtain coating apparatus constructed in accordance with the present invention.

Figure 3 is a transverse sectional view taken through the knife edge carrying member in the curtain coating apparatus illustrated in Figure 2.

Referring now to the drawings in detail, the relative position in a curtain coating apparatus of the structure constituting the improvement provided by the present invention, and its principles of operation, can best be understood by referring to the schematic illustration of Figure 1. A continuous elongated web which is to be coated by passage through the curtain coating machine is designated by reference character 10. The web 10 originates at a suitable conventional feed roll 12, is passed over an idler roll 14, and then is passed beneath a member 16 which extends transversely across the web 10, and is provided with an edge of reduced thickness or knife edge 18 at the lower side thereof. The knife edge 18 is in contact with the surface of the web 10 which is to be coated. In the

schematic illustration of Figure 1, this is the upper surface of the web.

After passing beneath, and in contact with, the knife edge 18 carried by the member 16, the web is passed through a gravitating curtain 20 of a molten coating composition. As is well understood in the art, the curtain 20 originates at a hollow coating head 22 which is provided with a slot (not seen) in the lower portion thereof to pass the composition. The molten coating composition is received in a receptacle or trough 24 which is positioned beneath the path of movement of the web 10 and in vertical alignment with the coating head 22. Suitable means (not shown) are provided for recycling the coating composition from the trough 24 through suitable pre-heater and degassing apparatus to the coating head 22.

After passing through the gravitating curtain 20, the continuous web 10 is passed over an idler roller 26, through chilling apparatus 28 and to a take-up or rewind roll 30.

The portion of the illustrated apparatus which constitutes the improvement of this invention is the member 16 carrying the knife edge 18 which contacts the web 10. We have found that when a structural element of this type is used in combination with the curtain coating apparatus and is positioned from about 1 to about 5 inches from the gravitating curtain 20 in the direction from which the web is moving, coatings which are considerably reduced in thickness, and yet which are continuous and defect-free may be laid down on the moving substrate. Preferably, the member 16 and the knife edge 18 which it carries are positioned so that the knife edge extends parallel to the gravitating curtain 20, and is positioned as close thereto as possible to yet avoid interference with the curtain. A spacing of about 1-1/2 inches from the curtain is usually desirable.

In tests which we have conducted, we have found that in the absence of the member 16 and the knife edge 18 placed in contact with the substrate, coatings of lesser thickness than 7.5 pounds of coating composition per ream (3000 feet square) cannot be uniformly deposited on typical cellulosic substrates. In any attempt to further decrease the thickness of the coatings by increasing the web speed through the curtain 20, or by decreasing the rate of flow of coating material from the coating head 22 to the trough 24, the coating fails to cover the web completely, and discontinuities, cracks or craters are formed therein. On the other hand, when the knife edge structure is included in the apparatus, and the knife edge 18 is brought to bear lightly upon the substrate in the position depicted in Figure 1, uniform continuous coatings having a thickness equivalent to the distribution of 5 pounds of the coating composition per ream of substrate have been

applied. No discontinuities or imperfections have been noted in these relatively thin coatings.

The principles by which the thinner coatings are achieved are not known with exactness, but it is believed that the member 16 and its associated knife edge 18 accomplish at least two functions which greatly assist in permitting the coating thickness to be reduced. First, the member 16 acts as a shield which prevents air currents and perhaps thermal conduction currents from impinging on the gravitating curtain 20, causing the curtain to waver or become thinner in one location along its transverse extent than in another. The blockage of air currents which is accomplished by the member 16 is particularly important, since air currents moving toward the curtain 20 are developed by the rapid movement of the substrate toward the curtain, and this is particularly true in the case of continuous substrates or webs of the type illustrated in Figure 1. The need for blocking or damping out the air currents moving with the substrate or continuous web is greatest closely adjacent the surface of the substrate which is to be coated, since the impingement of these air currents on the curtain at this point will have greater effect upon the uniformity of the coating laid down than will the impingement of such forces at points further removed vertically from the substrate. To the end of completely blocking the air movement immediately adjacent the surface of the substrate, the knife edge provides a continuous seal between the member 16 and the substrate and prevents flow of any air under the member 16 and into the gravitating curtain 20.

The second function which it is believed is provided by the member 16 and its associated knife edge 18 is that of damping out mechanical vibrations which are transmitted along the span of the web which extends through the gravitating curtain 20. Thus, as the knife edge 18 bears against the upper surface of the substrate, any vibrations or mechanical wave forms which may be progressing along the substrate between the points of support thereof on opposite sides of the curtain 20 are at least partially damped out or suppressed with the result that the coating composition makes initial contact with the substrate in a more uniform manner throughout the transverse extent thereof.

A preferred embodiment of the present invention as the same may be actually constructed for use in applying a coating composition to a moving substrate is illustrated in Figure 2 of the drawings. An elongated continuous web 40 constituting the substrate to be coated originates at feed rolls (not shown) and is passed over an idler roll 42 supported between generally horizontally extending side brackets 44. The idler roll 42

is vertically adjustable in the side brackets 44 for a purpose hereinafter to be explained. The side brackets 44 can be mounted on the framework (not shown) of the curtain coating apparatus in any suitable manner.

At the opposite ends of the side brackets 44 from the ends carrying the idler roll 42, the side brackets are longitudinally slotted so as to permit adjustable mounting of a pair of horizontally extending, spaced supporting arms 46. The supporting arms 46 may be adjustably mounted on the side brackets 44 by the use of bolts 48 extending through an elongated slot 49. The supporting arms 46 carry an elongated bar 50 which extends transversely across the web 40 and parallel to the gravitating curtain of coating composition which, in Figure 2, is designated by reference character 52. The elongated bar 50 is preferably adjustably supported in the arms 46 so that it may be moved vertically with respect thereto.

The lowest side of the elongated bar 50 is converged to a knife edge 54 which bears against the upper surface of the continuous web 40. In a preferred embodiment of the invention, the elongated bar 50 is hollow in construction with the hollow interior thereof communicating with a narrow, elongated opening in the knife edge 54 as best illustrated in Figure 3. A vacuum connection 56 is provided adjacent one end of the bar 50 to permit the hollow interior thereof to be evacuated. Alternatively, the connection 56 may be used for introducing air under pressure to the interior of the elongated, hollow bar 50.

Positioned above and in vertical alignment with the elongated bar 50 is an extension shield designated generally by reference character 60. The extension shield 60 is of a length which generally corresponds to the length of the elongated bar 50, and includes a rigid supporting frame 62 which supports and encloses a rigid, preferably transparent sheet of material 64, such as glass or a transparent plastic such as the material sold under the Registered Trade Mark "Plexiglas". The frame 62 of the extension shield is mounted on vertically extending rods 66 which extend upwardly from the extension shield 60 and are slidably supported on the framework (not shown) of the curtain coating apparatus. The rods 66 may thus be slidably adjusted in a vertical direction so that the extension shield 60 can be lowered until the lower edge thereof abuts the upper edge of the elongated bar 50.

At this point it should be noted that the extension shield 60 is currently provided on some types of curtain coating apparatus for the purpose of partially shielding the gravitating curtain of coating composition. In the arrangement which has been described wherein the knife edge carrying structure of the present invention is used conjunctively with

this shield, the primary reason for such arrangement is the present existence of the extension shield. In instances where the extension shield is not provided on the curtain coating apparatus, a continuous vertically extending shield structure may be formed integrally with the elongated bar 50, or may be secured to the top of this bar to function in substantially the same manner as the extension shield 60, that is, to provide additional shielding against air currents moving in the same direction as the direction of travel of the web 40, but displaced further vertically from the web 40 than the vertical dimension of the elongated bar 50.

After passing beneath the elongated bar 50 and in contact with the knife edge 54, the continuous web 40 moves through the gravitating curtain 52 of coating composition which descends from a hollow coating head 68 to a receptacle 72. The web 40 then passes over an idler roll 70 provided on the opposite side of the curtain 52. From the idler roll 70, the web passes through a suitable chilling chamber (not shown) where the molten composition is further set up or hardened by temperature reduction. The web is finally taken up on suitable take-up rolls (not shown).

In the operation of the apparatus of the invention, the substrate is passed beneath the elongated bar 50 and its associated knife edge 54 in a manner such that the surface of the substrate is in contact with the knife edge over the entire transverse width of the substrate. In the case of the continuous web 40 illustrated in Figure 2, this is accomplished by positioning the knife edge 54 slightly below the common plane which contains the upper surfaces of the idler rolls 42 and 70 while maintaining tension on the web. As the substrate passes beneath the elongated bar 50 in contact with the knife edge 54, vibrations of the substrate are damped out, and its surface receiving the coating composition is more quiescent and vibration-free. Moreover, the elongated bar 50 blocks air and thermal conduction currents moving with the web 40 toward the gravitating curtain 52 and prevents their impingement on the curtain. More complete blocking is obtained when the extension shield 60 is employed, or when a similar vertically extending structure is positioned superjacent the elongated bar 50.

The elongated bar 50 can be either a solid bar or can be the hollow construction illustrated in Figure 3. The hollow construction is preferred since by use of the hollow bar 50 in conjunction with the vacuum connection 56, the interior of the bar 50 may be evacuated, thus drawing the substrate against the knife edge 54 and maintaining a vacuum seal against air currents passing beneath the knife edge. Moreover, in some instances, it may be desired to permit the vacuum to act

along the substrate or that portion of the substrate between the knife edge 54 and the gravitating curtain 52. In this way, the tendency of the moving web to generate turbulence and moving air currents between the knife edge and the web is damped out by a slight suction or vacuum which draws air currents, which otherwise would tend to move toward the web, back into the hollow interior of the bar 50.

From the foregoing description of the invention, it will have become apparent that the present invention provides an improved curtain coating apparatus which permits thinner, continuous coatings to be applied to moving substrates than the coatings which can be applied with curtain coating apparatus heretofore in use. The structure is simple and easily constructed and maintained, and yet is characterized by mechanical strength, and a long and trouble-free operating life.

#### WHAT WE CLAIM IS:—

1. A curtain coating apparatus, comprising a slotted coating head arranged to provide, when in use, a gravitating curtain of a liquid coating composition emanating from the slot in the coating head, means for conveying a substrate through the curtain and below the coating head in a direction extending substantially normal to said gravitating curtain and a horizontally extending knife edge extending generally parallel to a vertical plane containing the slot in said coating head and horizontally spaced from said plane, said knife edge being positioned at a vertical level such that it is able to contact the upper surface of said substrate just before the substrate is moved through said gravitating curtain by said conveying means.

2. Apparatus as claimed in Claim 1, wherein said shield means extend vertically upwardly from said knife edge for blocking air currents moving in a direction normal to said vertical plane.

3. Apparatus as claimed in Claim 2, wherein said shield means is vertically adjustable.

4. Apparatus as claimed in any preceding Claim wherein said knife edge is slotted, and is provided with a member for connection to means for drawing air through the slot in said knife edge.

5. Apparatus as claimed in claim 4, wherein said knife edge comprises a hollow elongated bar terminating in said knife edge, the hollow interior of said bar communicating with the slot in said knife edge.

6. Apparatus as claimed in any preceding claim, wherein a receptacle is spaced vertically below the coating head to receive the gravitating curtain of liquid coating composition emanating from the slot in the coating head, and wherein said conveying means comprise first support means on one side of the vertical plane extending between the slot in said coating head and said receptacle for supporting a portion of the substrate as it is passed through said vertical plane in a direction normal thereto, and second support means on the opposite side of said vertical plane from said first support means, said second support means serving to support a portion of the substrate as it is passed through said plane in a direction normal thereto.

7. Apparatus as claimed in Claim 6 wherein said first and second support means each comprises a roller.

8. Apparatus as claimed in Claim 6 or 7, wherein said knife edge is vertically adjustable between vertical levels which are above and below a line extending between the portions of said first and second support means which contact and support said substrate whereby said knife edge will contact the surface of a substrate supported by said first and second substrate supporting means as the substrate is moved through said coating composition as the coating composition gravitates in said vertical plane.

9. Apparatus as claimed in Claim 8, wherein said knife edge is positioned in a horizontal plane extending generally parallel to, and disposed below, the horizontal plane occupied by said substrate as it is moved through said curtain.

10. A curtain coating apparatus substantially as hereinbefore described with reference to the accompanying drawings.

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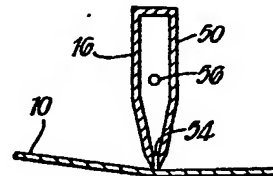
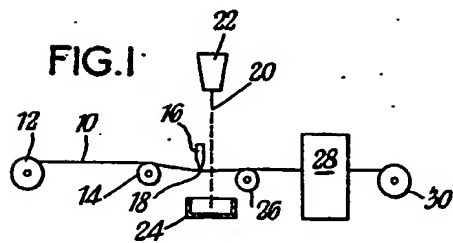
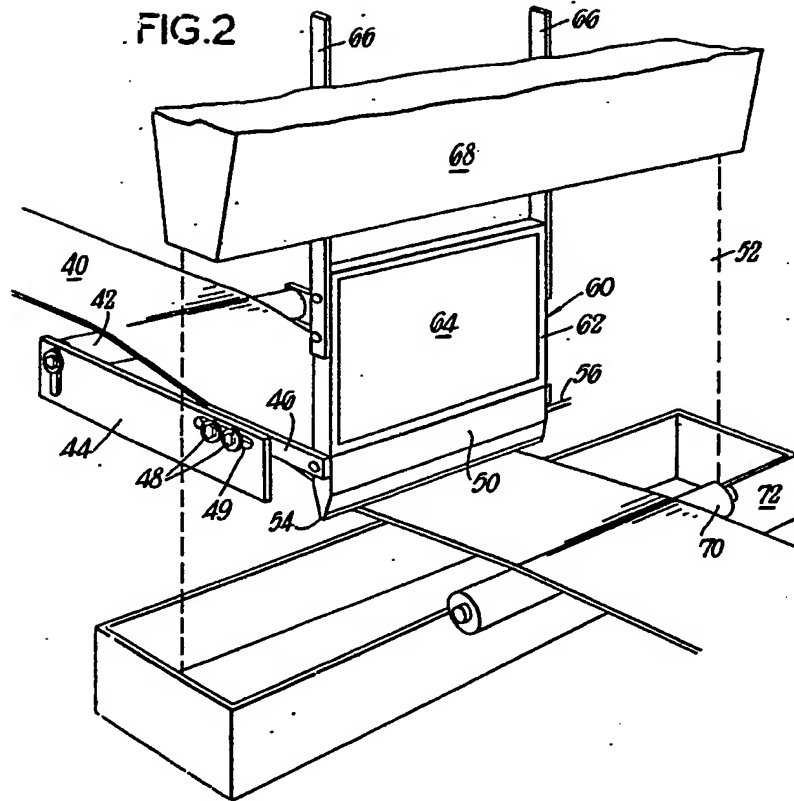


FIG.3